Space Weather Technical Forecast

Issued on Friday, 02 February 2024 at 01:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated R1/R2 Radio Blackouts. CME arrival expected, most likely late day 2 (3rd) or early day 3 (4th), with G1-G2/Minor to Moderate geomagnetic storms likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with several C-class flares, the largest of which was a long duration C3 flare, peaking at 01/0743 UTC. This appears to be associated with a surge from an area of enhanced flux in the northern hemisphere. This produced a CME, which has been analysed as being Earth-directed. There are currently seven sunspot regions on the visible disc, two of which are noteworthy. AR3567 in the northeast remains the largest region on the disc, and along with AR3565 and AR3573 is moderately magnetically complex, each region with beta-gamma configuration. Most remaining sunspot regions appear to be small and stable, or in decay. However, AR3573 has been increasingly slightly in size, developing new small leader spots of different polarity, which has pushed its classification to Cao/beta-gamma.
In addition to the CME associated with the C3 flare two further CME's have been seen leaving the Sun during the past 24 hours, one weak CME to the southeast during the morning and another more substantial CME from the far northwest in the evening. Currently both CME's are awaiting analysis, but are not thought to be Earth-directed.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE at L1, were indicative of a weak and waning coronal hole high speed stream, from slightly elevated to slow-ambient levels, before rising again to slightly elevated levels, due to the arrival of a weak CME at 01/0519 UTC (which left the Sun on 29 Jan). Wind speeds ranged from 390 to 460km/s throughout the period, and declined to background levels again as the weak CME passed. The solar wind density was average to below average throughout, despite the arrival a weak CME. The interplanetary magnetic field (IMF), Bt, was mostly weak, but briefly rose to moderate, peaking at 8nT following the CME arrival, with the north-south component, Bz, varying weakly, reaching +5 to -6nT. The Phi angle was predominantly negative (towards the Sun). The net result of the above solar wind measures was Quiet geomagnetic activity (Kp 0-2), despite the weak CME arrival.

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is currently at slightly elevated levels following the M6.8 flare on 29 Jan from EX-AR3559, but remains well below the S1/Minor Storm threshold.

GOES16 high energy (greater than 2MeV) electron flux was at normal background to moderate levels. The associated 24-hour fluence was well below the Active (1e8 integrated pfu) threshold but on a rising trend. At 02/0000 UTC the 24-hour integrated fluence observation was 5.2e6 integrated pfu.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Low, but with a chance of increasing to Moderate with isolated M-class flares, most likely from AR3565 or AR3567. However, later in the forecast period new or returning regions are expected to rotate onto the disc, which may increase solar activity.

Solar Wind / Geomagnetic Activity: Solar winds are currently at background levels. A CME from the 31 Jan may give a glancing blow at Earth either on day 2 or 3 (3rd or 4th Feb), although this is low confidence. There is higher confidence for the next CME, from the 1st Feb, to be Earth-directed, but lower confidence for the arrival time. The CME is most likely to arrive either late tomorrow or early day 3. The next anticipated HSS enhancement is from CH96/+ in the southern hemisphere. A leading portion of this CH may become weakly geo-effective from day 2 (3rd) but the majority of the HSS arrival is expected to be on day 4 (5th Feb), with solar wind speeds reaching 450-500 km/s. Geomagnetic activity is expected to remain Quiet (Kp 0-2) today. From tomorrow Quiet to Unsettled (Kp 1-3) conditions are expected, with occasional Active periods (Kp 4) expected and isolated G1-G2/Minor to Moderate geomagnetic storms (Kp 5-6) from late tomorrow through day 3 (4th).

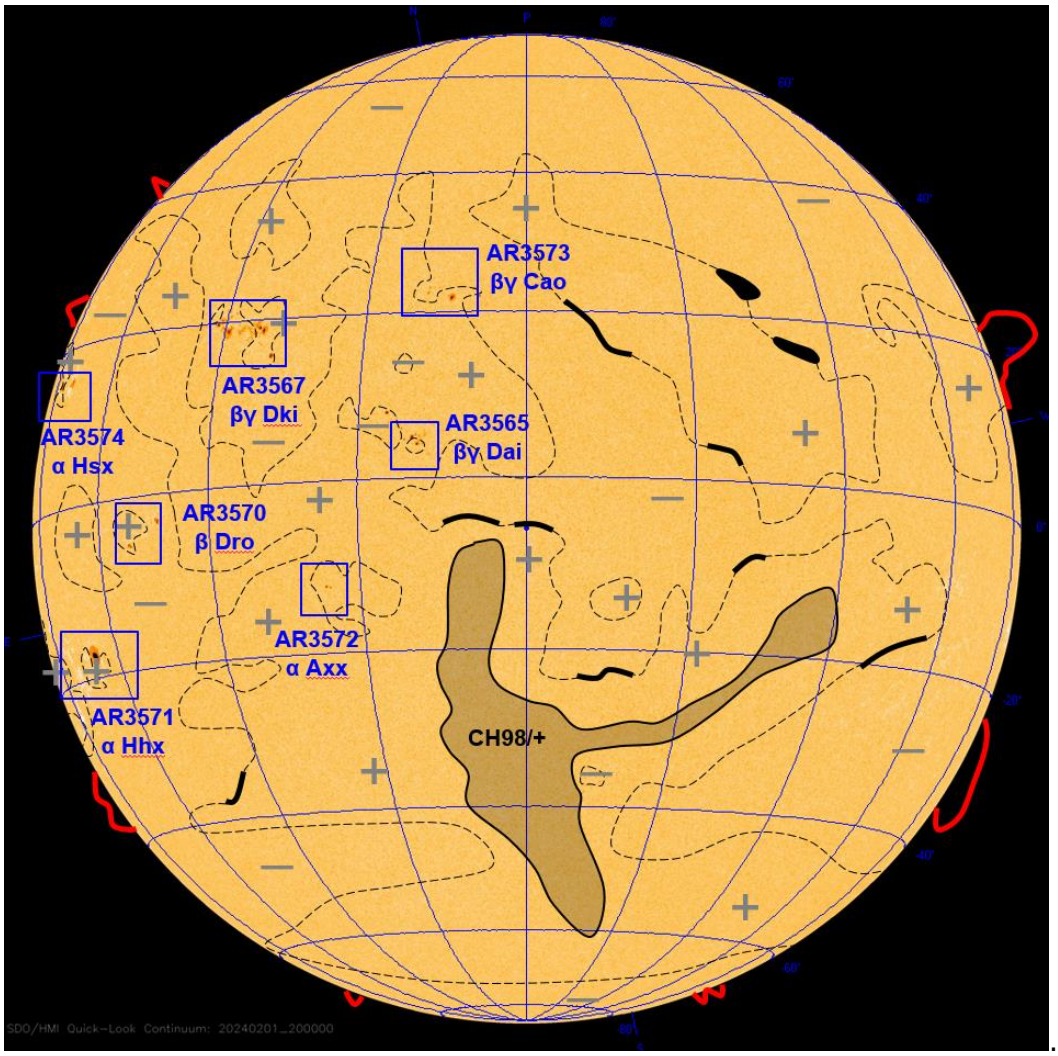
Energetic Particles / Solar Radiation: High energy proton flux is expected to remain below the S1/Minor Radiation Storm level, with a nominal risk of exceeding the S1 threshold during the period.

The high energy electron flux (greater than 2MeV) is expected to remain below High levels throughout the period, with exceedance of the Active threshold considered extremely unlikely.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1. Solar Analysis Valid 01/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms:

A weak CME arrived at Earth at 01/0520 UTC, which left the Sun on the 29 Jan in association with an M6.8 flare, which originated from Ex-AR3559. Solar winds temporarily reached slightly elevated levels, but have since declined to background levels.

A CME from the 31 Jan may give a glancing blow at Earth either on day 2 or 3 (3rd or 4th Feb), although this is low confidence. There is higher confidence for the next CME, from the 1st Feb, to be Earth-directed, but lower confidence for the arrival time. The CME is most likely to arrive either late tomorrow or early day 3, with the current MOSWOC Enlil model considered too fast The next anticipated HSS enhancement is from CH96/+ in the southern hemisphere. A thin and narrow extension of this CH may become weakly geo-effective from day 2 (3rd) but the majority of the HSS arrival is expected to be on day 4 (5th Feb), with solar wind speeds reaching 450-500 km/s. Geomagnetic activity is expected to remain Quiet (Kp 0-2) today. From tomorrow Quiet to Unsettled (Kp 1-3) conditions are expected, with occasional Active periods (Kp 4) expected and isolated G1-G2/Minor to Moderate geomagnetic storms (Kp 5-6) from late tomorrow through day 3 (4th).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	50	70	40
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1306 UTC	Partial	Flux area	NE	700	03/2100 UTC	Low confidence on timing, higher confidence for CME arrival.

Figure 2 – Solar dimming (left) associated with the long-duration C3 flare at 0738 UTC on 01 Feb in an area of enhanced flux, which produced a CME (right) seen in LASCO imagery.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

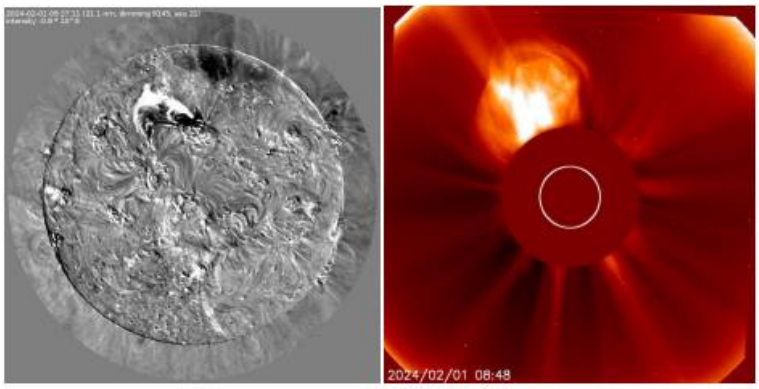


Figure 3: Latest MOSWOC Enlil, which is considered too fast for the arrival of the CME.

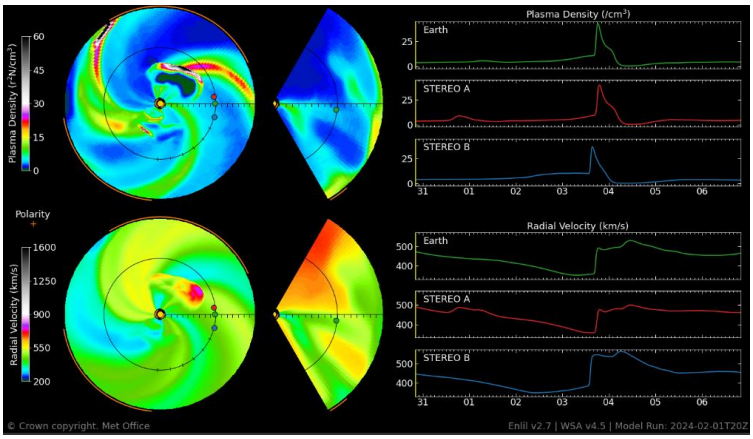
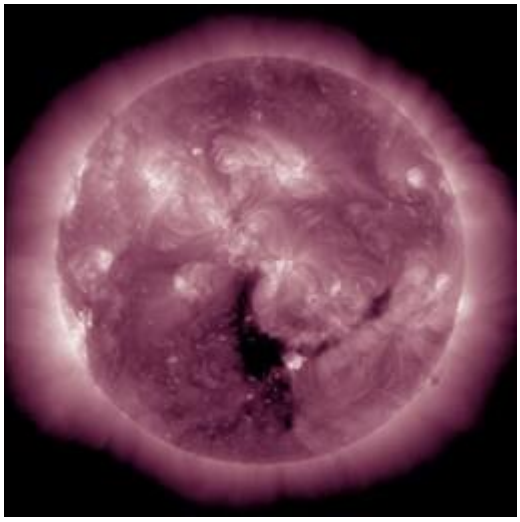


Figure 4: Latest SDO/AIA 211 image showing CH96, with the narrow westward extension.



Radio Blackouts - X-Ray Flares:

There are currently seven sunspot regions on the disc, two of which are noteworthy. AR3567 in the northeast remains the largest on the disc, showing slight growth in spot number since previous analysis. At the same time the penumbra around some intermediate spots appears to

© Crown Copyright 2024. All Rights Reserved.

have fragmented, resulting in the previous delta spot ceasing to exist. Both AR3565 and AR3573 in the northeast show moderate magnetic complexity, with beta-gamma configurations, due to AR3565's north-south magnetic alignment in its leading portion, and AR3573 recent gain of small leader spots of mixed polarity. However, AR3565 has shown a slight reduction in area recently. Most remaining sunspots appear to be small and weak, stable or decaying. However, newly numbered AR3574 is likely to be a more complex region than indicated, but is currently too close to the northeast limb for accurate analysis.

Low activity is expected with a chance of rising to Moderate with isolated M-class flares. These most likely from AR3565 and AR3567.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	45	45	45	45
Very Active	R3 to R5 X Class	No	5	5	5	5

Solar Radiation Storms - (High Energy Protons):

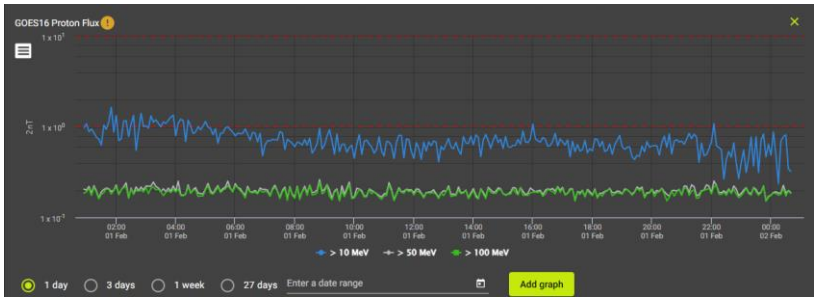
GOES18 high energy (greater than 10MeV) proton flux is currently at slightly elevated levels following the M6.8 flare on 29 Jan from EX-AR3559, but remains below the S1/Minor Storm threshold. The risk of breaching the S1 threshold is now only a Slight Chance, should any notable flares occur from the spots on the visible disk.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 5: Latest GOES 16 Proton flux

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

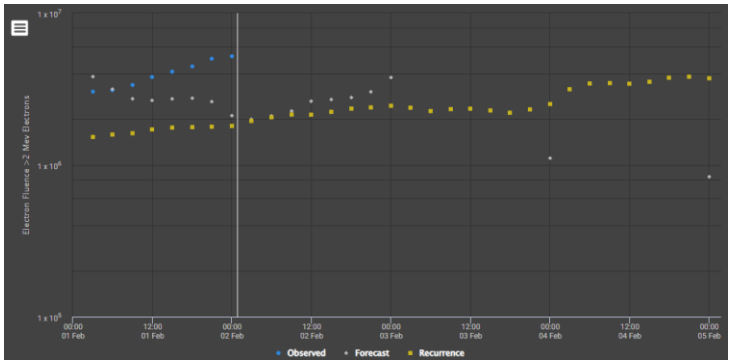


High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has spent the whole of the past 27-day rotation below High levels, and there is currently no reason for any significant changes. Therefore, the associated fluence is expected to remain well below the Active (1e8 integrated flux) threshold. MOSWOC REFM's projections and persistence values are currently underestimating the fluence, but still the overall advice of the fluence showing a very gradually rising trend whilst remaining below the Active threshold is expected.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 6: MOSWOC REFM model.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.